Reaction Mechanism Studies of Multi-nucleon Transfer Reactions in ^{208}Pb(^{16}O, x) and comparison with ^{206}Pb(^{18}O, x)

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Multi-nucleon transfers between heavy ions play important role for definition of the reaction mechanism that describes evolution of the reaction from quasi-elastic regime to more complex deep-inelastic reactions and provides a detailed insight into the underlying reaction mechanisms. Transfer reactions are also a competitive tool, beside studies of multi-particle correlations and nuclear structure, for production of neutron rich unstable nuclei whose production is difficult by other methods. With the availability of radioactive beams, the transfer processes give access to a wide field of nuclear structure studies in the far-off stability region. For example, production of super heavy elements and neutron-rich nuclei in A ≈ 200 mass region using multi-nucleon transfer reactions have been discussed in the literature. The multi-nucleon transfer processes are also expected to play a crucial role in the synthesis of heavy elements with neutron-rich projectiles. However, reactions involving transfer of many nucleons are not well understood. The cross section is usually rather small for projectile energies below Coulomb barrier[1]. The probability for multi-nucleon transfer increases at higher energies but the reaction mechanism becomes complicate as one has to deal with Q-integrated data. A systematic investigation of multi-nucleon transfer reactions and more experimental data using different target and projectile combinations would be needed for better understanding of the reaction mechanism aspects.

On theoretical front, models like GRAZING and Complex WKB (CWKB), which are based on a direct reaction picture, have been used extensively in describing the distributions of mass, charge and energy of outgoing fragments in different transfer channels. These models, though very successful for quantitative estimates of various observables for multi-nucleon transfers, but have some limitations and may not be well suited for light ions and at energies much above the Coulomb barrier (as in the present cases). The fully microscopic time-dependent Hartree - Fock (TDHF) calculation is the another approach which has been followed in the literature [2,3]. As the theory based on independent particle picture, predictions from TDHF calculations and detailed comparison with experimental data, can provide useful information on multi-particle correlation.

The experiment was carried out with ^{16}O beams (134.1MeV) at the Pelletron-LINAC facility, Mumbai. Enriched ^{208}Pb target was used. Projectile like fragments were detected with silicon SSB detectors in ΔE-E configuration. We could achieve a clear Z and A separation for transfer products. The particle identification spectrum is shown below.

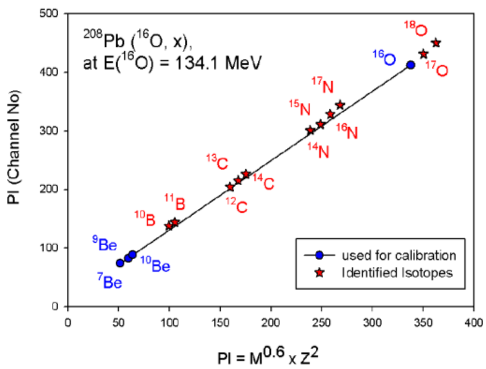

FIG. 1: Particle Identification spectrum

Elastic scattering angular distribution was also measured simultaneously. Optical model analysis of the measured $(d\sigma/d\Omega)_{el}$ was performed, potential parameters were extracted and are compared with $^{18}O+^{206}Pb$.

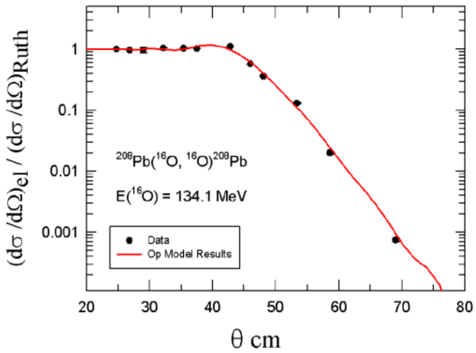

FIG. 2: The ratio of $\sigma_{elastic}$ to $\sigma_{Rutherford}$.

Angular distributions for Q-integrated data for all transfer channels are measured. Here only a few channels are plotted as representative cases.

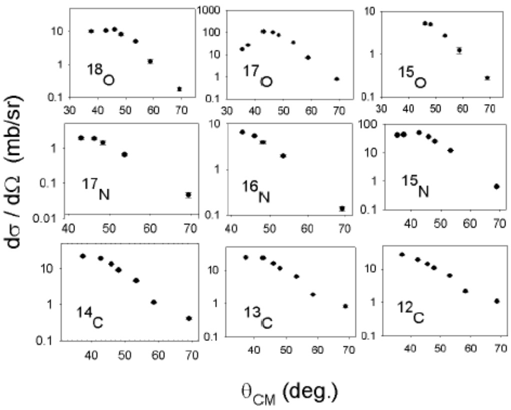

Fig.3: Angular distribution(preliminary results) for some of the transfer reactions in $^{208}Pb(^{16}O,x)$

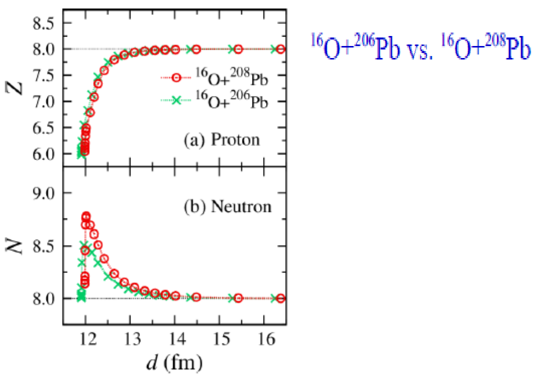

Fig. 4 TDHF calculations and comparison between $^{16}O+^{206}Pb$ and $^{16}O+^{208}Pb$. X-axis is the distance of closest approach(d).

The TDHF calculations are performed and results are presented in Figs.4-5 for the average no. of proton/neutron in the projectile like fragments. Our initial study indicates a very similar transfer dynamics irrespective of target ^{206}Pb or ^{208}Pb, neutron transfer is slightly enhanced because of the two additional neutrons in ^{208}Pb (Fig.4). With ^{18}O projectile(Fig.5), neutron transfers are observed to occur in opposite direction for y-direction case (x-, y- and z-directions represent different orientations between projectile and target in the collision[2]). Q- and θ-integrated cross sections at E(^{16}O) = 134.1MeV are plotted in Fig.6. The TDHF results will be compared with present expt. data.

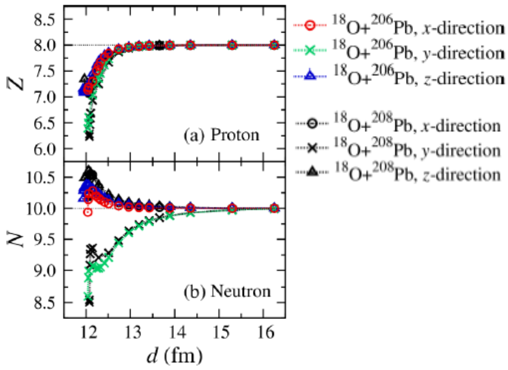

Fig. 5 TDHF calculations and comparison between $^{18}O+^{206}Pb$ and $^{18}O+^{208}Pb$.

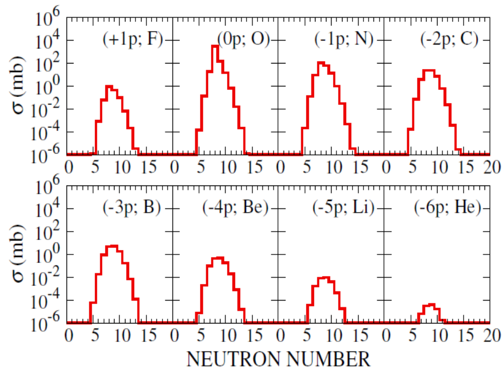

Fig.6 Calculated cross section for $^{208}Pb(^{16}O, x)$.

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